M2 AND MONETARY POLICY

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I. INTRODUCTION

Consistent with its mandate in the Humphrey-Hawkins Act of 1978, the Federal Reserve System each year sets a calendar-year target for the monetary aggregate M2. The M2 target is in the form of a cone with a base equal to the realized value of M2 in the fourth quarter of the previous year. In this form, the target does not fix the trend rate of growth of M2. Also, the level of the target changes as a consequence of base drift. That is, the level of a new target is changed each year by the amount of the previous year's target miss, where the miss is measured as the deviation in the fourth quarter between realized M2 and the midpoint of the target cone [Broaddus and Goodfriend (1984)].

This paper examines the effect of specifying the M2 target as a multiyear trend line. Such a target would determine the trend rate of growth of M2 and would eliminate random drift over time in M2.[1] If the trend line were set to rise by three percent each year, this form of M2 target would embody a proposal originally made by Milton Friedman (1960). What would an operationally significant, multiyear target for M2 in the form of a trend line rising at three percent per year imply about variables of fundamental concern, in particular, the dollar income of the public and the price level? The answer depends upon the behavior of the public's demand for real M2, that is, its demand for the purchasing power represented by M2. This assertion can be explained by reference to the quantity theory of money.

The quantity theory can be summarized in the formula $M = k \cdot I$, where M is money, k is the ratio the public maintains between its money balances and its dollar income, and I is dollar income. The quantity theory gives this formula economic content with the assumption that the behavioral relationship governing the money stock is largely independent from the behavioral relationships governing real variables.[2] The variable k, the ratio the public desires to maintain between its money balances and its income, is one way of expressing the public's demand for real money balances. The quantity theory assumes that over a significant period of time this real variable is determined in a way that is largely independent from the behavior of money (M). If the Fed constrains M2 (M) to adhere over time to a given target path, it follows that the behavior of dollar income (I) will be determined by the behavior of k.

Alternatively, the quantity equation can be expressed as $M = (k \cdot Q) \cdot P$. (In the formula above, substitute $P \cdot Q$ for I. The product of the price level, P, and real income, Q, equals dollar income, I.) The product $k \cdot Q$ is the amount of its real income the public desires to maintain in the form of real money balances. Both k and real income (Q) are real variables, and, over significantly long periods of time, are assumed to be determined in a fundamentally different way than the nominal variable M. If the Fed constrains M2 (M) to adhere over time to a given target path, it follows that the behavior of the price level (P) will be determined by $k \cdot Q$.

The paper examines the behavior of the public's demand for real M2. This behavior is shown to have changed very little over long periods of time, even with substantial financial innovation in the 1980s. Moreover, random disturbances to the public's demand for real M2 have tended to be offsetting over time. It follows that an M2 target in the form of a trend line that remains fixed over time can make the trend rate of growth in dollar income equal to the trend rate of growth in real income. The trend rate of inflation, consequently, can be made to equal zero. It also follows that such a target can eliminate over long periods of time much of the random drift currently exhibited by the price level.

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[1] The proposed rule would require the Fed to establish some form of a feedback rule running from M2 to its policy variable. A decision would need to be made about the extent of the change in the policy variable that would be triggered by deviations of M2 from the targeted trend line. This decision raises issues treated in the literature under the heading of the optimal amount of interest rate smoothing. [See Poole (1970).] These issues are not discussed here. Regardless of the way in which this aspect of policy is determined, random fluctuations in M2 would not affect the target path. The operating procedures actually chosen would, periodically, make M2 coincide with a fixed trend line.

[2] Real variables are expressed in terms of physical quantities or rates of exchange between physical quantities (relative prices). Dollar (nominal) variables are expressed in terms of current dollars.

The paper also examines the variability of the public's demand for real M2. Estimated money demand functions divide this variability into random and systematic components. Although the random changes to M2 demand tend to average out over time, they can be large for individual years. Also, the systematic changes in M2 demand due to changes in the cost of holding M2 are important over periods of a year or more. For these reasons, there is only a low correlation between M2 and income over periods of a year. Consequently, the proposed M2 target would not reduce significantly yearly fluctuations in income. Its value would lie in eliminating the tendency for the price level to rise in a sustained way.

II.
A LONG-RUN PERSPECTIVE ON M2 VELOCITY

M2 velocity is dollar income divided by M2 (the inverse of the variable k). In order to understand the implications of M2 targeting, it is important to know whether M2 velocity is stationary or nonstationary. A stationary series gravitates over time around a fixed value. A nonstationary series wanders aimlessly through time without any fixed reference point. The data indicate that M2 velocity is a stationary series.

Figure 1 shows M2 velocity (GNP divided by M2) starting in 1914.[3] The horizontal axis is drawn through the value of velocity in 1914 (1.6). M2 velocity exhibits greater variation before 1950, which may be due to the greater magnitude of shocks impinging on the economy. Over the entire period, velocity appears to be stationary. That is, velocity periodically returns to the horizontal axis.

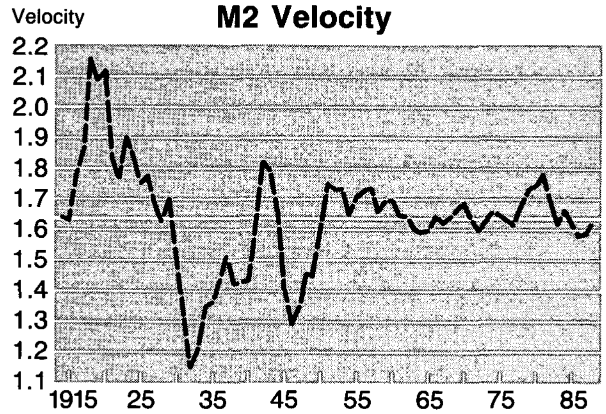
A general time-series model for M2 velocity is

$$(1)\quad V_t - m = c_1(V_{t-1} - m) + \epsilon_t.$$

That is, the current deviation of velocity (V) from its mean (m) equals some fraction of last period's deviation from the mean plus a random error, ϵ_t. Stationarity of velocity implies $c_1 < 1$. In this case, a deviation of velocity from its mean value tends to be reduced. Nonstationarity of velocity corresponds to the special case where $c_1 = 1$. In this case, the model becomes

Figure 1

M2 Velocity



Notes: M2 velocity is GNP divided by M2. From 1914 to 1929, GNP is from Balke and Gordon (1989). From 1930 on, GNP is from the Commerce Department. From 1914 to 1958, M2 is from Friedman and Schwartz (1970). Over this period, M2 is the latters' M4 series, with S&L shares interpolated when necessary. From 1959 to present, M2 is from the Board of Governors.

$$(2)\quad V_t = V_{t-1} + \epsilon_t.$$

A nonstationary series wanders randomly over time. As shown in (2), if velocity is nonstationary, the best prediction of current velocity will simply be last period's velocity, since ϵ_t by assumption is random noise.

The hypothesis of nonstationarity then can be tested by fitting the following regression:

$$(3)\quad \ln (V_t - \hat{m}) = c_1 \ln (V_{t-1} - \hat{m}) + \epsilon_t.$$

(ln is logarithm. The use of logarithms expresses velocity in (3) as a percentage deviation from its estimated mean value $\hat{m}$.) The hypothesis of nonstationarity is embodied in the null hypothesis $c_1 = 1$. The alternative hypothesis of stationarity is $c_1 < 1$.[4]

Table I displays the results of estimating regression (3) using annual average data. The lagged term, $\Delta\ln (V_{t-1} - \hat{m})$, was included because of the need to remove serial correlation from the errors. (Δ is the first-difference operator.) Because of the change in the variability of M2 velocity around 1950, the test is performed starting in 1950. The OLS t-test of the null hypothesis $c_1 = 1$ yields a statistic of -4.8

[3] Figure 1 uses GNP in the calculation of velocity since Balke and Gordon (1989) make GNP, but not income, available for a long period of time. In the remainder of the paper, velocity is defined as personal income divided by M2. Personal income is used because it worked somewhat better than GNP in the money demand regressions reported in Tables II and III.

[4] An alternative way to test for nonstationarity is to run the regression $(V_t - V_{t-1}) = c_0 + c_1 V_{t-1} + \epsilon_t$. The hypothesis of nonstationarity is then the null hypothesis that $c_0 = c_1 = 0$. With $c_0 = c_1 = 0$, the regression corresponds to model (2). The relevant test statistic is an F statistic, whose distribution is given in Dickey and Fuller (1981). This regression was run in logs and with one lagged first difference of velocity to eliminate serial correlation in the residuals. The test in this form yields the same result as the test in the form reported in Table I.

Table I

VELOCITY AUTOREGRESSION, 1950 TO 1988

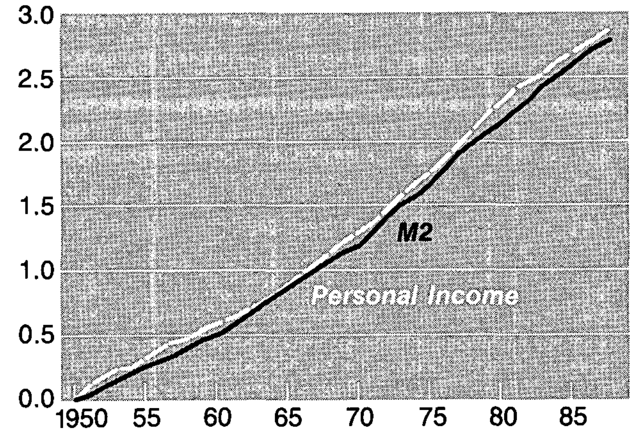
$$\ln V_t = \underset{(.083)}{.60} \ln V_{t-1} + \underset{(.127)}{.36} \Delta \ln V_{t-1} + \hat{\epsilon}_t$$

CRSQ = .64	SEE = .023	DW = 1.7	DF = 37

Notes: Observations are annual averages of the ratio of personal income to M2, divided by the average value of these observations from 1950 to 1988. ln is the logarithm. Δ is the first-difference operator. CRSQ is the corrected R-squared; SEE standard error of estimate; DW the Durbin-Watson statistic. DF is degrees of freedom. Standard errors in parentheses. Estimation is by OLS.

Figure 2

M2 and Personal Income



Notes: Observations are annual values of the natural logarithm of an index number that uses the year 1950 as a base value.

[(.60 − 1)/.083]. Fuller (1976, Table 8.5.2) gives −3.75 as the critical value for a test at the 1 percent significance level of the null hypothesis that $c_1 = 1$. The hypothesis that c_1 equals one can be rejected at the 1 percent level of significance. M2 velocity appears to be stationary.[5]

Stationarity of M2 velocity means that M2 and dollar income move together over time. Figure 2 shows annual observations of M2 and personal income from 1950 to 1988. Each series was put in index number form by dividing its values by the series' 1950 value. Logarithmic values are plotted, so each series starts in 1950 with a common base of zero. Although the divergence between the M2 and the income series for particular years is significant, the divergence between the two series does not grow over time. It follows that an operationally significant M2 target in the form of a trend line would cause dollar income to fluctuate around a fixed trend line.

Assuming that the proposed M2 target made income fluctuate around a fixed trend line, how large would these income fluctuations be? In answering this question, it is useful to examine M2 demand functions, which split variability in M2 demand into systematic and random components. The effect of an M2 target in the form of a trend line can then be discussed with respect to each kind of variability[6].

III. M2 DEMAND FUNCTIONS

In order to understand the variations in velocity shown in Figure 1, it is necessary to take account of changes in the cost of holding M2. This point is illustrated by Figures 3 and 4. Figure 3 shows M2 velocity (personal income divided by M2) and a measure of the interest foregone by holding M2 rather than a money market instrument. Specifically, the money market opportunity cost of holding M2 is measure of the interest foregone by holding M2 rather than a money market instrument. Specifically, the money market opportunity cost of holding M2 is measured as the interest rate on commercial paper minus a weighted average of the explicit rates of interest paid on the components of M2. When money market rates rise relative to the rates paid on the components of M2 like time and savings deposits, it becomes more costly to hold M2. The public then holds fewer M2 balances relative to its income and velocity therefore rises. Conversely, when it becomes less costly to hold M2, velocity falls.

Figure 4 shows M2 velocity and the rate of inflation, which is used as a proxy for the cost of

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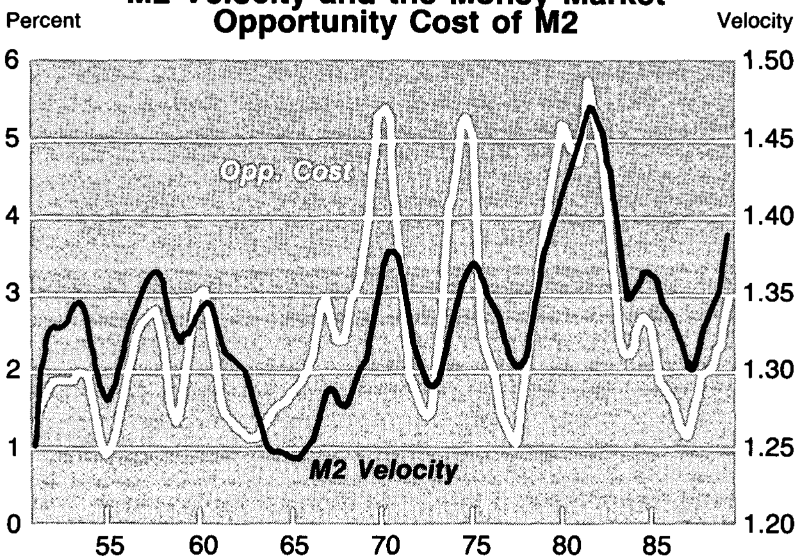
[5] The test for nonstationarity of M2 velocity was also performed for the period from 1914 through 1988. Velocity was defined as the ratio of GNP to M2 and the Balke-Gordon (1989) GNP data were used from 1914 through 1929. Thereafter, Commerce Department data were used. M2 velocity was first expressed as a deviation from its mean value over this period. The velocity series was then normalized so that its variance was the same before and after 1950. The series from 1914 through 1949, expressed as deviations from the mean, was divided by its standard deviation over this period. The velocity series from 1950 through 1988 was adjusted similarly, and the resulting series were combined. Using this series, a regression was then run like the one shown in Table I. The hypothesis of nonstationarity, as before, was tested with the null hypothesis that the coefficient on lagged velocity is one. The hypothesis of nonstationarity can almost, but not quite, be rejected for the period 1914 through 1988 at the 1 percent level of significance.

[6] The magnitude of fluctuations in income would also depend upon the aspect of policy referred to in footnote 1, that is, whether the degree of interest rate smoothing chosen is optimal. The optimal amount of smoothing increases with the importance of random shocks to money demand relative to random shocks to real aggregate demand [Poole (1970)].

Figure 3

M2 Velocity and the Money Market Opportunity Cost of M2



Notes: Velocity is personal income divided by M2. The money market opportunity cost of M2 is the 4-6 month commercial paper rate minus a weighted-average of the explicit rates of interest paid on the components of M2. Observations are four-quarter moving averages of the contemporaneous value and three lagged values. Tick marks above years correspond to first quarter of year.

holding M2 rather than physical assets.[7] When inflation rises, it becomes more costly to hold M2, and velocity rises. Conversely, when inflation falls, velocity falls. Figure 4 also shows that changes in inflation tend to lead changes in velocity. Apparently, when inflation changes, significant time is required for the public to substitute between M2 and physical assets.

Figures 3 and 4 suggest the following regression equation to explain the public's demand for real M2.

$$(4) \quad \ln \frac{M_t}{P_t \cdot N_t} = c_0 + c_1 \ln \frac{I_t}{P_t \cdot N_t} - c_2(R_t - RM_t) - c_3 \, \Delta \ln P_t + \mu_t$$

M is M2, P the price level, N population, I income, R the interest rate in the money market, RM the own rate of return on M2, and μ an error term. The natural logarithm is ln. The left-hand variable is (the log of) real per capita M2. The right-hand variables are a constant, (the log of) real per capita income, the difference between a money market rate of interest and the weighted average of the explicit rates paid on the components of M2, and the rate of inflation ($\Delta \ln P_t$, which is the difference in the log of the price level in periods t and t-1).

This regression was fit for the years 1950 through 1988 with a contemporaneous value and one lagged value on the right-hand variables. A simpler regression without distributed lags on the right-hand variables, however, yielded values for the estimated coefficients very close to the values of the sum of the estimated coefficients in the first regression. The latter, simpler regression, is shown in Table II. It includes one contemporaneous term for real income and the money market opportunity cost of holding M2 and one lagged term, but no contemporaneous term, for inflation.

The regression results shown in Table II indicate that an increase of one percentage point in the money market opportunity cost of holding M2 produces a decrease of 1.33 percent in real M2 demand. They also indicate that an increase in the inflation rate of one percentage point produces, with a lag of one year, a decrease of .79 percent in real M2 demand.

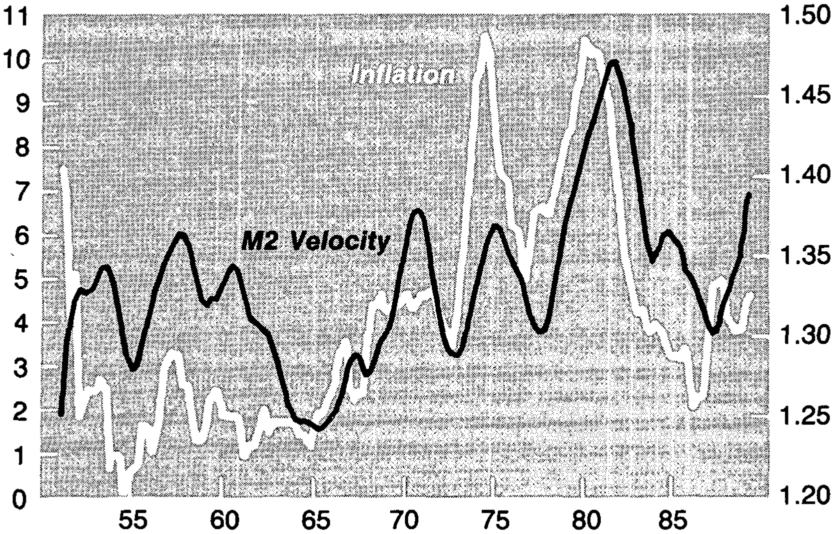
The standard error of estimate (SEE in Table II) is one measure of the average annual variation in real M2 demand due to random disturbances unrelated to changes in real income and in the cost of holding M2. In percent, it is 2.3. (The low value of the Durbin-Watson statistic shows that there is a significant amount of persistence in these random disturbances.) The largest annual random disturbance to the public's real M2 demand was an overprediction of −3.7 percent, which occurred in 1951. There is then considerable random annual variation in real M2 demand.

Estimation using data in level form, as in Table II, could produce a good fit spuriously. The regression could fit a trend in the left-hand variable, real M2, to a trend in one of the right-hand variables, especially real income, even though these trends are unrelated economically [Granger and Newbold (1974)]. The low Durbin-Watson statistic of these regressions (indicating high first-order serial correlation of the residuals) suggests the possibility that the regression is explaining only the trend of real M2,

[7] The nominal return to holding physical assets is the sum of the rental rate on these assets plus the change in their price expected by the public. Neither of these variables is observable. The proxy used for this return, the rate of inflation, does not capture the rental rate on physical assets. In addition, actual inflation is not necessarily a good measure of the public's expectation of the change in prices on physical assets. Despite these drawbacks, Figure 4 does show a positive correlation between M2 velocity and inflation.

Figure 4

Inflation **M2 Velocity and Inflation** Velocity



Notes: Velocity is personal income divided by M2. Observations are four-quarter moving averages of the contemporaneous value and three lagged values. Inflation is four-quarter percentage changes in the implicit consumption expenditures price deflator. Tick marks above years correspond to first quarter of year.

not its annual variation. Differencing the variables, by removing trends in the data, eliminates this potential problem. Differencing, however, removes common trends that may in fact be important for explaining economic relationships. There is no clear criterion for choosing between regressions using data in level form and in first-differenced form.

Fortunately, the absence of deterioration in fit in regressions estimated using differences indicates that the spurious regression phenomenon mentioned above is not a problem. Also, the estimated coefficients are similar in regressions using data in level form and in first-differenced form. This similarity indicates that differencing does not produce an unacceptable loss of information. Table III reports regression results over the years 1950 to 1988 using differences.[8] Percentage changes in real per capita M2 are regressed on percentage changes in real per capita income, changes in the money market opportunity cost of holding M2, and changes in the rate of inflation.[9] The right-hand variables are entered with a contemporaneous term and one lagged term.[10]

Table II

REAL M2 DEMAND REGRESSION, 1950 TO 1988

$$\ln \frac{M_t}{P_t \cdot N_t} = \underset{(4.1)}{-.20} + \underset{(55.2)}{1.01} \ln \frac{I_t}{P_t \cdot N_t} - \underset{(4.0)}{1.35} (R_t - RM_t) - \underset{(3.7)}{.73} \Delta \ln P_{t-1} + \hat{\mu}_t$$

CRSQ = .99 SEE = .023 DW = .60 DF = 35

Notes: M is M2; P the personal consumption expenditures deflator; N population of the U.S.; I personal income; R the 4-6 month commercial paper rate expressed as a decimal; RM the own rate of return on M2. Data are annual averages. ln is the natural logarithm. Δ is the first-difference operator. CRSQ is the corrected R-squared; SEE the standard error of estimate; DW the Durbin-Watson statistic. DF is degrees of freedom. Absolute value of t statistics in parentheses. Estimation is by OLS. The right-hand variables include one contemporaneous term for real income; one contemporaneous term for the money market opportunity cost of holding M2; and one lagged term, but no contemporaneous term, for inflation.

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[8] A regression was estimated using differenced data and one contemporaneous and lagged value on the right-hand variables, but with the calculated rate of return on M2 entered as a separate variable, rather than in the form of a difference with the commercial paper rate. That is, the own rate of return on M2 was entered separately from the rates of return on the substitutes for M2, money market instruments and physical assets. This regression yielded almost the same estimates of the coefficients on the real income and inflation variables as shown in Table III. The estimates of the coefficients on the paper rate and on the own rate of return on M2 were practically of the same magnitude, but with a negative coefficient on the paper rate and a positive coefficient on the M2 own rate. This unconstrained regression, then, suggested the essentially identical regression of Table III, where the paper rate and the M2 own rate are entered as a difference. Entering the opportunity cost variable for physical capital as the difference between the inflation rate and the own rate of return on M2 resulted in little change for regressions using first differences, but produced a deterioration of fit for regressions in level form.

The regressions shown in Tables II and III are similar to the regressions that Friedman and Schwartz (1982) estimate in their Table 6.14. They calculate the money market opportunity cost variable for M2 differently, however. (Essentially, they assume that banks could costlessly evade the prohibition of payment of interest on demand deposits and Reg. Q.) They also prefer the percentage change in GNP, rather than inflation, as the opportunity cost variable for physical capital. Use of the percentage change in GNP, rather than inflation, in the regressions shown in this paper resulted in approximately the same fit for regressions run with differenced data. The fit deteriorated for regressions run with data in level form, however.

[9] Δln, a first difference in logarithms, yields a continuously compounded percentage change. Δ is a simple first difference.

[10] The first differences of the data are multiplied by the filter $(1 - .16L - .25L^2)$,

Table III

CHANGE IN REAL M2 DEMAND REGRESSION, 1950 TO 1988

$$\Delta \ln \frac{M_t}{P_t \cdot N_t} = \underset{(7.7)}{.84} \, \Delta \ln \frac{I_t}{P_t \cdot N_t} - \underset{(7.9)}{2.12} \, \Delta(R_t - RM_t) - \underset{(5.4)}{1.01} \, \Delta(\ln P_t - \ln P_{t-1}) + \hat{\upsilon}_t$$

CRSQ = .85 SEE = .012 DW = 2.0 DF = 33

Notes: Δ is the first-difference operator. The right-hand variables include a contemporaneous term and one lagged term. The sum of the estimated coefficients (and absolute value of its t statistic) is shown. The estimated coefficients on the contemporaneous and lagged terms (absolute value of t statistics in parentheses) are for $\Delta \ln (I_t/P_t \cdot N_t)$, .33 (3.2) and .51 (4.9); for $\Delta(R_t - RM_t)$, −.87 (4.9) and −1.25 (6.1); and for $\Delta(\ln P_t - \ln P_{t-1})$, −.62 (5.1) and −.39 (3.6). The first differences of the data are multiplied by the filter $(1 - .17L - .26L^2)$, where L is the lag operator.

The magnitude of the coefficients estimated on the opportunity cost variables rises somewhat in comparison to the regression using data in level form. Differencing eliminates the upward trend over the 1950 to 1988 period in the money market opportunity cost of holding M2 and in inflation. The upward trend in these variables correlates with the upward trend in real M2 and appears to have biased downward the estimates of the coefficients on these variables reported in Table II. Increases of one percentage point in the money market opportunity cost of holding M2 and in the inflation rate are now estimated to reduce real M2 demand by 2.13 and 1.04 percent, respectively.

Do the random disturbances to the public's demand for real M2 (the μ_t of a regression like the one estimated in Table II) average out over time or cumulate? Alternatively, does the left-hand variable in money demand regressions, real M2, move together or diverge over time from the right-hand variable, real income. The relevant statistical test is whether the disturbances in an M2 demand regression are stationary or nonstationary. The test is performed as above in the test of the stationarity of velocity. Nonstationarity of disturbances to money demand implies that the best prediction of the current value of a disturbance (μ_t) is the prior disturbance (μ_{t-1}). In the regression equation (5), nonstationarity implies that $c_1 = 1$ and ξ_t is a white noise error.

(5) $\mu_t = c_1 \mu_{t-1} + \xi_t$

The estimated money demand errors used to fit (5) are taken from a money demand regression like the one shown in Table II, which uses annual observations in level form. The regression included a contemporaneous and one lagged value for each right-hand variable. The contemporaneous disturbance estimated from this regression is regressed on its own lagged value. See Table IV. (No lagged first differences were needed in order to eliminate serial correlation in the errors.) The null hypothesis of nonstationarity is that the coefficient on the lagged term is one.

The OLS t-test of the null hypothesis that the true value of the coefficient on $\hat{\mu}_{t-1}$ equals one yields a statistic of −3.8 [(.44 − 1)/.147]. Fuller (1976, Table 8.5.2) gives −3.75 as the critical value for a test of the null hypothesis at the 5 percent significance level. The null hypothesis of nonstationarity can be rejected at the 5 percent level of significance. [Also, see Mehra (1989).] Random disturbances to real M2 demand tend to average out over time.

Because real M2 and real income both possess strong positive trends, neither are stationary variables. Stationarity of the disturbances estimated from the M2 demand regression equation implies, however, that the difference between real M2 (the left-hand variable of the regression) and real income (a right-hand variable) is stationary. Real M2 $(\frac{M}{P})$ and real income (Q) move together over time.

Because real M2 $(\frac{M}{P})$ and real income (Q) move together over time, it follows that money per unit

Table IV

AUTOREGRESSION OF M2 DEMAND ERRORS 1951 TO 1988

$$\hat{\mu}_t = \underset{(.147)}{.44} \, \hat{\mu}_{t-1} + \hat{\xi}_t$$

CRSQ = .20 SEE = .018 DW = 2.0 DF = 37

Notes: The $\hat{\mu}_t$ is the estimated error from a regression in the form shown in Table II. The regression used to generate the errors included a contemporaneous and one lagged term on the right-hand variables. The standard error is in parentheses.

where L is the lag operator. That is, each data point is a first difference minus .16 times the difference one period prior and minus .25 times the difference two periods prior. This filter removed residual autocorrelation in the errors left after first differencing. The coefficients used in the filter are derived from the fitted errors obtained in a regression like that of Table III, except using simple first differences. The contemporaneous fitted error from this regression was regressed on its two prior lagged values. The estimated coefficients on these lagged values are the values used in the filter.

of output ($\frac{M}{Q}$) and the price level (P) move together over time. The quantity equation can be written as $\frac{M}{P} = k \cdot Q$. Stationarity of disturbances to M2 demand is a reflection of the stationarity of M2 velocity, or its inverse, k. This stationarity implies that $\frac{M}{P}$ and Q move together over time. When the quantity equation is rearranged as $\frac{M}{Q} = k \cdot P$, it is seen that stationarity of M2 velocity also implies that money per unit of output ($\frac{M}{Q}$) and the price level (P) move together over time.

If each of the Series in Figure 2 is divided by real income (Q), the graph would plot M2 per unit of output ($\frac{M}{Q}$) and the price level (P).[11] Like the series shown in Figure 2, these transformed series do not diverge over time. A target for M2 (M) in the form of a given trend line then will tie down the price level (P), apart from random permanent disturbances to real income (Q). These disturbances affect the denominator of money per unit of output ($\frac{M}{Q}$) and will affect the price level (P) permanently. Such disturbances cause the price level to drift away over time from any given base value. Such drift, however, is small relative to the drift in the price level caused by the current drift in M2. A trend-line target for M2 fixed over time would largely eliminate the present amount of drift in prices. This statement is illustrated below.

Note first, however, that the regression analysis of Table II yields an estimate of the income elasticity of demand for real M2 (the estimated value of c_1) of one. It follows that the trend rate of growth of real M2 and of real income are the same. This fact is shown in Figure 1 by the trendlessness of M2 velocity. The quantity equation can be written as $V = Q/(M/P)$. The trend rate of rise in Q and M/P is the same. If a trend-line target for M2 rose at the same rate as the trend rate of growth in real income, say, three percent per year, the trend rate of rise in the price level would be zero.[12] On average, the increase in the demand for real M2 would be supplied by the increase in M2. On average, there would be no need for the price level to change.

Consider now the Friedman proposal that M2 be made to grow at 3 percent per year. As noted in the introduction, the quantity equation can be written as $M = (k \cdot Q) \cdot P$. In percentage change form, and with k equal to a constant over a long period of time, this formula implies that the trend rate of growth of money (M) will equal the trend rate of growth of real income (Q) plus the trend rate of growth of prices (P). Assuming that the trend rate of growth of real income is three percent, it follows that the trend rate of growth of prices will equal the trend rate of growth of money minus three percent.

This last formula was used to predict the change in the price level since 1950. The price level (consumption expenditures deflator) and M2 were expressed as index numbers with a base of 100 in 1950. The figure for the percentage excess of M2 over a trend line rising at three percent per year was used as the prediction of the percentage change in the price level from its 1950 base. The value of the index number for the price level in 1988 was predicted to be 517, while its actual value was 475. The actual value of the price level then was 8.5 percent below the predicted value. It follows that if procedures had been in place since 1950 to constrain M2 to grow around a trend line rising at three percent per year, the price level in 1988 would have fallen from 100 in 1950 to 91.5, a decline of 8.5 percent. Instead, the price level rose to 475. An operationally significant trend-line target for M2 will eliminate most of the drift over time in the price level.

IV. M2 DEMAND AND FINANCIAL INNOVATION IN THE 1980s

The average magnitude of the estimated errors of the regressions in Tables II and III is no larger in the 1980s than in other periods. Financial innovation has not affected the stability of the M2 demand function. One reason is that the definition of M2 has imposed considerable continuity on the kinds of financial instruments included in M2. M2 is composed of transactions instruments and savings instruments available in small denominations.[13] It excludes money market instruments, which are issued in large

[11] This form of Figure 2 has long been used by quantity theorists. See, for example, Friedman (1958 and 1987). Humphrey (1989) provides a history of the graph.

[12] Over the period 1950 to 1988, the trend rate of growth of real GNP was almost exactly 3 percent.

[13] The exception is overnight Eurodollars and overnight repurchase agreements. These instruments, which are good substitutes for corporate demand deposits, do not comprise a significant fraction of M2.

There is a quirk in the definition of M2 that reduces its economic continuity over time. M2 includes time deposits less than $100,000. With inflation, over time, the definition of M2 includes continually fewer time deposits representing a large amount of purchasing power. The $100,000 value used to exclude large time deposits should be indexed to change with the inflation rate.

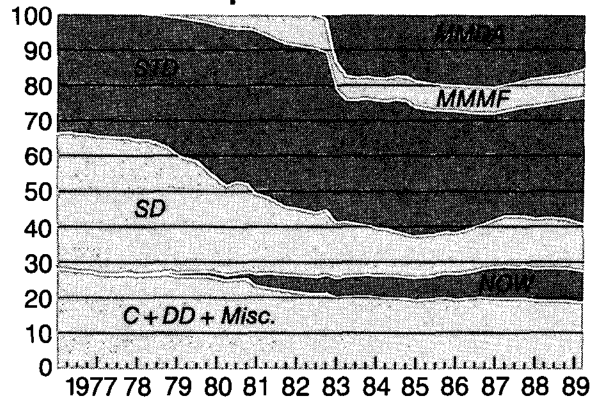
denominations, except to the extent that such instruments are made available in small denominations through money market mutual funds. Figure 5 shows the composition of M2 over time.

To understand why financial innovation in the 1980s altered the character of the public's demand for M1, but not M2, one must understand how this innovation altered the substitutions among savings instruments prompted by changes in market rates. The nationwide introduction of the NOW account in 1981 changed the character of these substitutions and, in the process, changed the character of M1. [See Hetzel and Mehra (1989) and Mehra (1989).] Because NOW accounts pay interest, they are used as a savings instrument, as well as an instrument for effecting transactions.[14] Both demand deposits and NOW accounts offer check writing privileges. NOW accounts, in contrast to demand deposits, however, are good substitutes for the other savings instruments in M2.

The instruments in M2 used as savings vehicles are NOWs, savings deposits, small time deposits, money market deposit accounts (MMDAs), and money market mutual fund shares (MMMFs). The rates paid on small time deposits, on MMDAs, and on MMMFs change promptly with changes in money market interest rates. In contrast, the rates paid on NOWs and savings deposits change only slowly as money market rates of interest change. Figure 6 plots a money market rate, the commercial paper rate. It also plots the difference between the paper rate and a weighted average of the rates paid on small time deposits, MMMFs, and MMDAs, as well as the difference between the paper rate and a weighted average of the rates paid on NOWs and savings deposits. When market rates fall, the attractiveness of small time deposits, MMMFs, and MMDAs changes only slightly. The rates offered on these deposits fall in line with market rates, so the difference between market rates and the rates they offer changes only slightly. In contrast, when market rates fall, NOWs and savings deposits become more attractive. Because the rates offered on these deposits

Figure 5

Components of M2



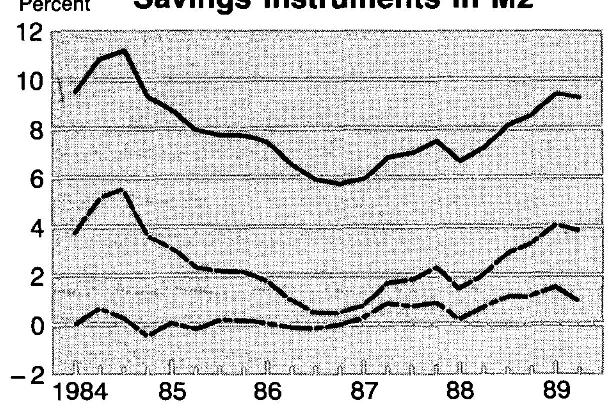
Notes: Percentage of M2 by component. C is currency; DD demand deposits; NOW other checkable deposits, chiefly NOW accounts; SD savings deposits; STD small time deposits; MMMF money market mutual funds of noninstitutional investors; and MMDA money market deposit accounts. Misc. is overnight RPs, overnight Eurodollars, and travelers checks.

change only slowly, the difference between market rates and the rates they offer narrows.[15]

Consequently, when market rates fall, individuals take funds out of small time deposits, MMDAs, and

Figure 6

Paper Rate and Rate Differential for Savings Instruments in M2



Notes: Top line is 4-6 month commercial paper rate. Middle line is difference between paper rate and a weighted average of rates paid on NOWs and savings deposits. Bottom line is difference between paper rate and a weighted average of rates paid on MMDAs, MMMFs, and small time deposits.

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[14] Prior to the introduction of NOWs, banks paid implicit interest on consumer demand deposits by offering check clearing services below cost. This practice made the average return paid by banks on demand deposits positive. An individual could increase the implicit yield on his demand deposits by writing more checks on a given balance. He could not, however, increase the return offered on his demand deposits by holding additional deposits. The marginal return on demand deposits was zero. With the introduction of NOWs, the marginal return to holding a checkable deposit in this form increased from zero to 5.25 percent, the ceiling rate under Regulation Q. Because a marginal rate of 5.25 percent was often close to the level of money market rates, individuals began to use NOWs as an instrument for saving in small denominations.

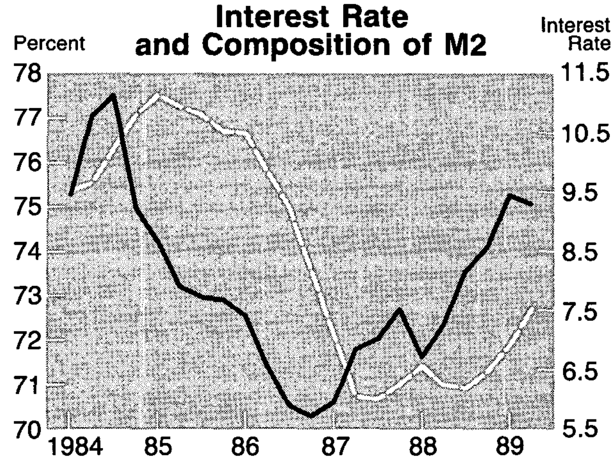
[15] After 1987, the weighted average of rates paid on small time deposits, MMDAs, and MMMFs does not change quite as quickly as market rates. The reason is that changes in MMDA rates are becoming less sensitive to changes in money market rates. Increasingly, banks are competing for interest-sensitive funds solely through small time deposits and through "tiering." Tiering is the practice of offering a rate of interest that is kept competitive with money market rates only on deposits that require a large minimum balance.

MMMFs and place them in NOWs and savings deposits. When market rates rise, they reverse this transfer. Figure 7 shows that, when market rates fall, the share of savings-related deposits in M2 made up of small time deposits, MMMFs, and MMDAs decreases, while the share of NOWs and savings deposits increases. When market rates rise, this change in shares is reversed.

These substitutions among instruments used as savings vehicles have affected the behavior of M1. When market rates fell in late summer 1982 and again in fall 1984, the rates paid on small time deposits, MMMFs, and MMDAs (MMDAs were in existence in 1984, but not 1982) fell much more than did the rate paid on NOWs. Consequently, the public substituted out of small time deposits, MMMFs, and MMDAs into NOWs. Because small time deposits, MMMFs, and MMDAs are not included in M1, this substitution increased the rate of growth of M1. All these deposits, however, are included in M2, so the behavior of M2 was unaffected. In sum, the deregulation and financial innovation of the 1980s has altered the character of the public's demand for M1, but not M2.

Figure 7

Interest Rate and Composition of M2



Notes: Solid line is the 4-6 month commercial paper rate. Dashed line shows the fraction of consumer savings-related deposits in M2 with interest rates sensitive to market rates: (STD + MMMF + MMDA) / (OCD + SD + STD + MMMF + MMDA). See Figure 5 for definition of mnemonics. Tick marks indicate first quarter of year.

V. THE RECENT BEHAVIOR OF M2 AND INCOME

The quantity equation can be written as I = M·V, that is, dollar income equals money times the velocity of money. M2 velocity is a function of the money market opportunity cost of holding M2 [(R − RM)] and of the rate of inflation [Inf]. Expressing the preceding equation in percentage change form (using Δln) and making changes in velocity a function of changes in the money market opportunity cost of holding M2 [Δ(R − RM)] and of changes in the rate of inflation [ΔInf] yields

$$(6) \quad \Delta\ln I = \Delta\ln M + \Delta\ln V[\Delta(R - RM), \Delta Inf].$$

That is, the percentage change in income (Δln I) equals the percentage change in money (Δln M) plus the percentage change in velocity (Δln V), which depends upon changes in the money market opportunity cost of holding M2 and in the rate of inflation. Below, the right side of this equation is used to predict the growth of dollar income over the recent past.

Table V displays the M2 determinants of growth in dollar income, summarized by the rate of growth of M2 and by estimated changes in M2 velocity deriving from changes in the cost of holding M2. Column 1 shows actual year-over-year percentage changes in personal income (%ΔI). Column 2 shows an estimate for this figure (Est. %ΔI) derived from the sum of the percentage change in M2 (%ΔM2) and of the percentage change in velocity attributed to changes in the cost of holding M2 (Est. %ΔV). (Column 2 is the sum of Columns 3 and 4.) Column 3 shows actual year-over-year percentage changes in M2 (%ΔM2). Column 4 shows the estimated, combined effect on changes in M2 velocity of changes in the money market opportunity cost of holding M2 and of changes in inflation. (Column 4 is the sum of Columns 5 and 6.)

Column 5 is an estimate of the change in M2 velocity produced by changes in the money market opportunity cost of holding M2, $\Delta(R_t - RM_t)$. For each year, the contemporaneous and prior year's values of $\Delta(R_t - RM_t)$ are multiplied by the appropriate coefficient estimated in the regression shown in Table III, and the sum of these two terms is reported in Column 5. Column 6 is an estimate of the change in M2 velocity produced by changes in the rate of inflation, $\Delta(\ln P_t - \ln P_{t-1})$. For each year, the contemporaneous and prior year's values of $\Delta(\ln P_t - \ln P_{t-1})$ are multiplied by the appropriate coefficient estimated in the regression equation shown in Table III, and the sum of these two terms is reported in Column 6.

Table V brings out, for the recent past, the importance of changes in the cost of holding M2 for the relationship between M2 and income. The magnitude of the figures in Column 4 shows that velocity changes due to changes in the cost of holding real M2 have been important determinants of changes in income. Since 1978, M2 growth has been fairly steady at around 8 percent. (The major exceptions are 1983, when M2 growth was augmented by the

Table V

MONETARY DETERMINANTS OF INCOME GROWTH

	(1) %ΔI	(2) Est. %ΔI	(3) %ΔM2	(4) Est. %ΔV	(5) %V[Δ(R – RM)]	(6) %V[ΔInf]
1977	10.2	10.3	11.9	–1.6	–1.2	–.4
1978	12.0	10.6	8.2	2.3	1.7	.7
1979	11.5	12.7	7.9	4.8	3.4	1.4
1980	10.5	11.1	7.7	3.3	1.7	1.6
1981	11.0	8.9	9.0	–.1	.2	–.3
1982	5.8	5.3	8.9	–3.5	–.9	–2.6
1983	6.1	6.6	11.8	–5.0	–2.8	–2.2
1984	9.1	5.6	7.7	–2.1	–1.3	–.8
1985	6.7	8.1	8.6	–.5	–.1	–.4
1986	5.9	5.6	8.0	–2.4	–1.7	–.7
1987	6.9	7.4	6.4	1.0	0.0	1.0
1988	7.3	6.8	5.0	1.8	1.4	0.4

Notes: Col (1): %ΔI is the percentage change in personal income calculated using annual average data. *Col (2): Est %ΔI* is the estimated percentage change in income calculated as the sum of columns (3) and (4), i.e., (2) = (3) + (4). Col (3): %ΔM2 is the percentage change in M2 calculated using annual average data.

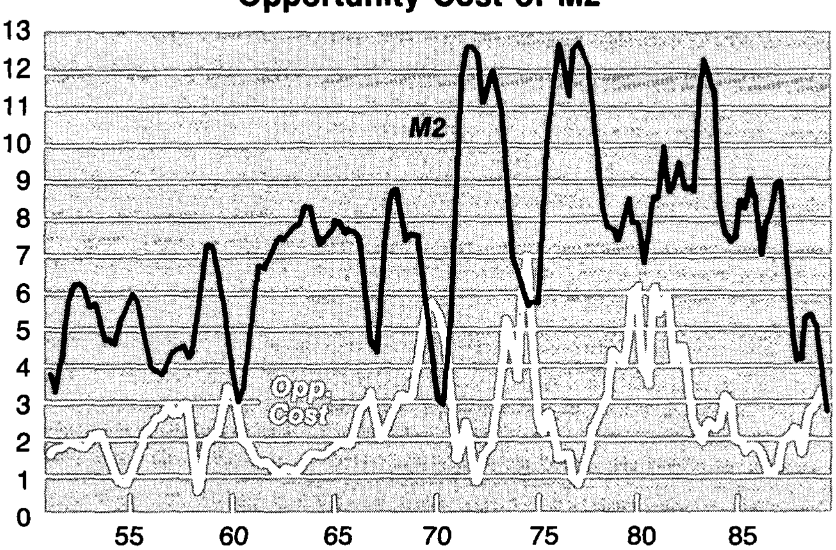
Col (4): Est %ΔV is the estimated *percentage change* in M2 velocity calculated as the sum of the estimated impact on velocity of changes in the money market opportunity cost of M2, Δ(R – RM), from column (5) and the estimated impact on velocity of changes in inflation, *ΔInf, from column* (6), i.e., (4) = (5) + (6).

Col (5): %V[Δ(R – RM)] is the estimated impact on velocity of the percentage point change in the annual average money market opportunity cost of holding M2: the 4-6 month commercial paper rate minus a weighted average of the rates paid on M2. The values in column (5) show the sum of the estimated impact on velocity of the contemporaneous and lagged values of Δ(R – RM) using the regression coefficients from Table III. For year t, these values are $.87\ \Delta(R_t - RM_t) + 1.25\ \Delta(R_{t-1} - RM_{t-1})$.

Col (6): %V[ΔInf] is the estimated impact *on* velocity of the percentage point change in the annual average rate of inflation, measured by the personal consumption expenditures deflator. The values in column (6) show the sum of the estimated impact on velocity of the *contemporaneous and lagged* values of $\Delta[\ln P_t - \ln P_{t-1}]$ using the regression coefficients from Table III: $.62\ \Delta(\ln P_t - \ln P_{t-1}) + .39\ \Delta(\ln P_{t-1} - \ln P_{t-2})$.

Figure 8

Growth of M2 and the Money Market Opportunity Cost of M2



Notes: Quarterly observations of four-quarter percentage changes in M2. The money market opportunity cost of M2 is the 4-6 month commercial paper rate minus a weighted-average of the explicit rates of interest paid on the components of M2. Tick marks above years correspond to first quarter of year.

introduction of MMDAs, and 1988, when M2 growth slowed.) Since 1978, changes in the thrust of monetary policy have derived more from changes in the cost of holding M2, than from changes in the growth of M2.

This last fact is apparent from Figure 8, which shows the rate of growth of M2 and the money market opportunity cost of holding M2. The initial contractionary effects of the reduction in the rate of growth of M2 that began in 1977 were more than offset by the increase in the money market opportunity cost of holding M2. Monetary policy, therefore, remained expansionary in the last part of the 1970s. In the 1980s, despite steady growth in M2, monetary policy became contractionary because of the fall in the money market opportunity cost of holding M2.

Table V illustrates that even over periods of time as long as one or two years the relationship between changes in income and in M2 can be quite loose. For this reason, M2 is not particularly useful as an intermediate target in procedures designed to control movements in income over periods as short as a year. Nor is it very useful as an information variable for inferring the contemporaneous behavior of income. M2 velocity is predictable over significant periods of time, however, as was shown earlier in the article. An M2 target can be used as part of a procedure for controlling income and prices over a long period of time.

VI. POLICY IMPLICATIONS

Prior to the 1980s, most economists considered M1 to be the most useful monetary aggregate for monetary policy.[16] It was easy then to use M1 as a predictor of income because of the insensitivity of M1 demand to interest rates. M1 also corresponded to the a priori definition of money as a medium of exchange. The deregulation and financial innovation of the 1980s, however, have altered the characteristics of the public's M1 demand function. M1 now is an instrument for saving as well as for effecting transactions. Asset substitutions between NOWs and savings instruments not included in M1 have caused large fluctuations in M1 demand in the 1980s. In contrast, M2 is defined broadly enough to eliminate the asset substitutions that have changed the character of the M1 demand function.

In order to ensure satisfactory behavior of the price level, monetary policy must provide for control of the money stock. A definition of money useful for monetary policy is one that provides a predictable relationship with the price level. The long-run predictability of M2 velocity makes M2 a useful definition of money for monetary policy. Brunner and Meltzer (1971) much earlier described aptly the reasons for using M2 now in the formulation of monetary policy.

> The recognition of the central role of a medium of exchange does not imply that the collection of assets that serve as medium of exchange is most appropriate for explaining movements of the general price level. A definition embracing a larger collection of assets is appropriate if there are close substitutes for the medium of exchange on the supply side. In this case, slight changes in relative prices reallocate [wealth] between the medium of exchange and other assets, so the collection of assets most useful for explaining the general price level differs from the assets that serve as medium of exchange [p. 803].

M2 velocity is stationary. Over time, the values taken on by velocity gravitate around a fixed base. Because M2 velocity is stationary, an operationally significant M2 target in the form of a trend line would cause dollar income to grow around a trend line. M2 velocity exhibits no trend. On average, real income and real M2 grow at the same rate. It follows that M2 growth equal on average to the trend rate of growth of real income will make the trend rate of inflation equal to zero.

[16] Milton Friedman, who emphasizes M2, is an obvious exception.

References

Balke, Nathan S., and Robert J. Gordon. "The Estimation of Prewar Gross National Product: Methodology and New Evidence." *Journal of Political Economy* 97 (February 1989): 38-92.

Broaddus, Alfred, and Marvin Goodfriend. "Base Drift and the Longer Run Growth of M1: Experience from a Decade of Monetary Targeting." Federal Reserve Bank of Richmond *Economic Review* 70 (November/December 1984): 3-14.

Brunner, Karl, and Allan Meltzer. "The Uses of Money: Money in the Theory of an Exchange Economy." *American Economic Review* 61 (December 1971): 784-805.

Dickey, David A., and Wayne A. Fuller. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." *Econometrica* 49 (July 1981): 1057-72.

Friedman, Milton. "The Supply of Money and Changes in Prices and Output." In *The Relationship of Prices to Economic Stability and Growth*, 85th Cong., 2nd sess., Joint Economic Committee Print, 1958. Reprinted in Milton Friedman. *The Optimum Quantity of Money and Other Essays.* Chicago: Aldine Publishing Co., 1969, pp. 171-87.

————. *A Program for Monetary Stability.* New York: Fordham University Press, 1960.

————. "Monetary History, Not Dogma." *The Wall Street Journal*, February 12, 1987, Op-Ed page.

Friedman, Milton, and Anna J. Schwartz. *Monetary Statistics of the United States.* New York: National Bureau of Economic Research, 1970.

————. *Monetary Trends in the United States and the United Kingdom.* Chicago: The University of Chicago Press, 1982.

Fuller, Wayne A. *Introduction to Statistical Time Series.* New York: John Wiley & Sons, 1976.

Granger, C. W. J., and P. Newbold. "Spurious Regressions in Econometrics." *Journal of Econometrics* 2 (July 1974): 111-20.

Hetzel, Robert L. "The Monetary Responsibilites of a Central Bank." Federal Reserve Bank of Richmond *Economic Review* 74 (September/October 1988): 19-31.

Hetzel, Robert L., and Yash Mehra. "The Behavior of Money Demand in the 1980s." *Journal of Money, Credit, and Banking* 21 (November 1989), forthcoming.

Humphrey, Thomas M. "Precursors of the P-Star Model." Federal Reserve Bank of Richmond *Economic Review* 75 (July/August 1989): 3-9.

Mehra, Yash. "Some Further Results on the Source of Shift in M1 Demand in the 1980s." Federal Reserve Bank of Richmond *Economic Review* 75 (September/October 1989): 3-13.

Poole, William. "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model." *Quarterly Journal of Economics* 84 (May 1970): 197-216.

APPENDIX

CONSTRUCTION OF A RATE OF RETURN SERIES FOR M2 AND CONSTRUCTION OF M2 PRIOR TO 1959*

1. Introduction

This appendix explains the construction of the rate of return series for M2. This series is constructed as a weighted average of the explicit rates of return on the various components of M2. This appendix also explains the construction of an M2 series prior to 1959 consistent with the current definition of M2. As currently defined, the M2 series published by the Board of Governors is only available starting January 1959.

The monetary aggregates were redefined in 1980 ("The Redefined Monetary Aggregates," *Federal Reserve Bulletin*, February 1980, pp. 97-114). Prior to 1980, M2 was defined as M1 plus time and savings deposits at commercial banks, minus negotiable CDs $100,000 or greater at weekly reporting banks. Since 1980, M2 has been defined as M1 plus overnight RPs issued at commercial banks, overnight Eurodollar deposits held by U.S. residents at branches of U.S. banks worldwide, money market mutual fund shares, savings deposits at *all* depository institutions, and time deposits at *all* depository institutions issued in denominations less than $100,000, minus a consolidation component.

Section 2 describes the construction of the M2 series prior to 1959Q1. Table AI of Section 2 lists the mnemonics and sources for the components of M2 that enter into formulas (2) and (3) for calculating the rate of return on M2 prior to 1959Q1. Section 3 (Table AII) lists the mnemonics and sources for the components of M2 that enter into formula (4) for calculating the rate of return on M2 from 1959Q1 on. Section 4 (Tables AIII and AIV) lists the mnemonics and sources for the interest rates paid on the components of M2. Section 5 shows the formulas used to construct the rate of return series on M2.

2. M2 Prior to 1959Q1

Data on the components of M2 prior to 1959Q1 are from Milton Friedman and Anna Schwartz (*Monetary Statistics of the United States*, New York: National Bureau of Economic Research, 1970, Table 1, pp. 4-53). Basically, for the period before 1959Q1, the M2 series used is the aggregate M4 reported in Table 1 of Friedman and Schwartz. Prior to 1950Q1, end-of-year observations on S&L shares were interpolated to yield quarterly observations, and from 1950Q1 to 1955Q1, end-of-quarter observations on S&L shares were interpolated to yield quarterly-average observations. These quarterly-average estimates of S&L shares were used in the construction of quarterly figures for M2 from the Friedman and Schwartz M4 series.

The M1 component of M2 prior to 1959 includes demand deposits of foreign commercial banks and institutions. These deposits were dropped from M1 as redefined in 1980, but had to be included in the observations prior to 1959 for lack of data.

* Robert LaRoche contributed to this appendix.

Table AI

COMPONENTS OF M2, PRIOR TO 1959Q1

Mnemonic	Description	Source
M1SA	M1, seasonally adjusted	F&S1 8
DCB	Time and savings deposits at commercial banks	F&S1 3
DSB	Deposits at mutual savings banks	F&S1 5
DPS	Deposits with postal savings system	F&S1 6
DTH	Deposits at S&Ls	F&S1 7
M2SA	M2, seasonally adjusted	F&S1 13

Notes: The number following F&S1 (Friedman and Schwartz, Table 1) refers to the column number of the data in F&S, Table 1. The series are seasonally adjusted.

3. M2 from 1959Q1 to Present

Data are from the Federal Reserve Board's Public Money Library (PML) and Friedman and Schwartz *Monetary Statistics*, Table 1.

Table AII

COMPONENTS OF M2, 1959Q1 TO PRESENT

Mnemonic	Description	Source
OCDC	Other checkable deposits at commercial banks (1974Q1-)	PML 125
OCDT	Other checkable deposits at thrift institutions (1970Q1-)	PML 147
M1NSA	M1, not seasonally adjusted (1959Q1-)	PML 198
SD	Savings deposits of all depository institutions (1959Q1-)	PML 470
STD	Small time deposits of all depository institutions (1959Q1-)	PML 475
DPS	Deposits with postal savings system (Ends 1967Q3)	F&S1 6
ONRP	Overnight repurchase agreements issued by commercial banks to other than depository institutions and MMMFs (1970Q1-)	PML 452
ONED	Overnight Eurodollar deposits issued by foreign branches of U.S. commercial banks to U.S. residents (1977Q1-)	PML 461
MMDAC	Money market deposit accounts at commercial banks (1982Q4-)	PML 239
MMDAT	Money market deposit accounts at thrift institutions (1982Q4-)	PML 345
MMF	General purpose and broker/dealer money market funds(1973Q1-)	PML 404
M2NSA	M2, not seasonally adjusted (1959Q1-)	PML 498

Notes: PML is the Federal Reserve Board's Public Money Library. The number following PML is the line number of the data series in this database. These series are not seasonally adjusted. DPS is taken from Friedman and Schwartz, Table 1, and is seasonally adjusted. The dates in parentheses show the periods for which each series is non-zero.

The other checkable deposits series, OCDC and OCDT, contain Super NOW accounts over the period of the latter's existence from 1983Q1 to 1986Q1.

4. Interest rates on components of M2

Data on rates of return before 1950Q1 are from Friedman and Schwartz *Monetary Statistics* (Table 9, pp. 173-4). The annual data were interpolated to obtain quarterly data.

Table AIII

RATES OF RETURN PRIOR TO 1950Q1

Mnemonic	Description	Source
RDCB	Rate on commercial bank time deposits	F&S9 1
RDSB	Rate on mutual savings bank deposits	F&S9 2
RDPS	Rate on deposits with postal savings system	F&S9 3
RDTH	Rate on savings and loan shares	F&S9 4

Notes: The number following F&S9 refers to the column number in Friedman and Schwartz, Table 9. Rates of return are expressed as simple annual rates.

Data on rates of return from 1950Q1 to present are from the Board's Quarterly Model (QM) database, from the Board's Macro Data Library (MDL), and from a database kept by the Monetary Studies Section at the Board. Monthly data are averaged in order to yield quarterly series.

Table AIV

RATES OF RETURN FROM 1950Q1 TO PRESENT

Mnemonic	Description	Source
ROCDE	Rate on other checkable deposits (1970Q2-)	*
RSAVEFF	Rate on savings deposits (1950Q1-)	QM
RSTDEFF	Rate on small time deposits (1959Q1-)	QM
RDPS	Rate on deposits with postal savings system (Ends 1967Q3)	F&S9 3
RONRP	Rate on overnight repurchase agreements (1972Q1-)	MDL
RONED	Rate on overnight Eurodollar deposits (1971Q1-)	MDL
RMMDACE	Rate on money market deposit accounts at commercial banks (1982Q4-)	*
RMMDATE	Rate on money market deposit accounts at thrift institutions (1982Q4-)	*
RMMFE	Rate on money market funds (1974Q3-)	*

Notes: QM refers to the Board's Quarterly Model database. MDL refers to the Board's Macro Data Library. RSAVEFF and RSTDEFF are the mnemonics used on the QM for the rate on savings deposits and the rate on small time deposits, respectively. The mnemonics on the MDL corresponding to RONRP and RONED are RMDLRRPM and &EDONM, respectively. Series with a "*" in the Source column are taken from a database kept by the Board's Monetary Studies Section and have the same mnemonics as the corresponding series on that database. The number following F&S9 refers to the column number in Friedman and Schwartz, Table 9. The dates in parentheses show the periods over which each series is non-zero.

With the exception of RONRP and RONED, the rate of return series kept on the Board's databases are expressed as effective annual rates. The former are expressed as simple annual rates as is the RDPS series, which is taken from F&S, Table 9. (All series are in the form in which they are found in the sources.)

The RSTDEFF series begins in 1959Q2. (The 1959Q1 value was set at 2.7, the 1959Q2 value.) Prior to 1959Q1, the RSAVEFF series is used in place of RSTDEFF.

ROCDE is a weighted average of the effective annual yields on OCDs at commercial banks and at thrift institutions. From 1983Q1 to 1986Q1, yields on Super NOWs are included in the average.

5. Calculation of rate of return for M2

This section calculates a weighted-average rate of return on M1 (RM1) and M2 (RM2) using rates on the components of these aggregates. Currency, travelers checks, and demand deposits enter in with a zero weight because they do not pay an explicit rate of return.

Calculation of RM1

(1) $RM1 = (1/M1NSA) [(OCDC + OCDT) \cdot ROCDE]$

Notes: The RM1 series is zero until 1970Q2. The other checkable deposit series, OCDC and OCDT, contain Super NOWs over the period of their existence from 1983Q1 to 1986Q1.

Calculation of RM2

Prior to 1950Q1:

(2) $RM2 = (1/M2SA) [DCB \cdot RDCB + DPS \cdot RDPS + DSB \cdot RDSB + DTH \cdot RDTH]$

For 1950Q1 to 1958Q4:

(3) $RM2 = (1/M2SA) [(DCB + DSB + DTH) \cdot RSAVEFF + DPS \cdot RDPS]$

For 1959Q1 to present:

(4) $$RM2 = (1/M2NSA) [M1NSA \cdot RM1 + SD \cdot RSAVEFF + DPS \cdot RDPS + STD \cdot RSTDEFF + ONRP \cdot RONRP + ONED \cdot RONED + MMDAC \cdot RMMDACE + MMDAT \cdot RMMDATE + MMF \cdot RMMFE]$$

Table AV

RATE OF RETURN FOR M2 (RM2)

Year	Quarter	RM2	Year	Quarter	RM2	Year	Quarter	RM2	Year	Quarter	RM2
1946	1	0.47	1958	1	1.08	1970	1	3.07	1982	1	8.97
1946	2	0.47	1958	2	1.11	1970	2	3.16	1982	2	8.78
1946	3	0.47	1958	3	1.14	1970	3	3.18	1982	3	7.82
1946	4	0.48	1958	4	1.16	1970	4	3.18	1982	4	6.35
1947	1	0.49	1959	1	1.21	1971	1	3.19	1983	1	6.39
1947	2	0.49	1959	2	1.25	1971	2	3.15	1983	2	6.48
1947	3	0.50	1959	3	1.28	1971	3	3.20	1983	3	6.88
1947	4	0.50	1959	4	1.31	1971	4	3.23	1983	4	6.88
1948	1	0.52	1960	1	1.35	1972	1	3.23	1984	1	7.04
1948	2	0.53	1960	2	1.39	1972	2	3.23	1984	2	7.47
1948	3	0.53	1960	3	1.43	1972	3	3.27	1984	3	7.97
1948	4	0.53	1960	4	1.45	1972	4	3.33	1984	4	7.27
1949	1	0.57	1961	1	1.49	1973	1	3.42	1985	1	6.63
1949	2	0.57	1961	2	1.52	1973	2	3.67	1985	2	6.23
1949	3	0.58	1961	3	1.60	1973	3	4.52	1985	3	5.87
1949	4	0.58	1961	4	1.64	1973	4	4.55	1985	4	5.87
1950	1	0.37	1962	1	2.04	1974	1	4.65	1986	1	5.78
1950	2	0.38	1962	2	2.13	1974	2	4.57	1986	2	5.29
1950	3	0.38	1962	3	2.16	1974	3	4.45	1986	3	4.88
1950	4	0.39	1962	4	2.16	1974	4	4.32	1986	4	4.63
1951	1	0.40	1963	1	2.19	1975	1	3.94	1987	1	4.62
1951	2	0.41	1963	2	2.22	1975	2	3.81	1987	2	4.76
1951	3	0.42	1963	3	2.30	1975	3	3.92	1987	3	4.93
1951	4	0.43	1963	4	2.30	1975	4	3.87	1987	4	5.13
1952	1	0.44	1964	1	2.33	1976	1	3.88	1988	1	5.10
1952	2	0.46	1964	2	2.35	1976	2	3.93	1988	2	5.10
1952	3	0.47	1964	3	2.36	1976	3	3.98	1988	3	5.38
1952	4	0.48	1964	4	2.37	1976	4	4.05	1988	4	5.64
1953	1	0.50	1965	1	2.48	1977	1	4.02	1989	1	6.10
1953	2	0.51	1965	2	2.50	1977	2	4.07	1989	2	6.40
1953	3	0.52	1965	3	2.52	1977	3	4.22			
1953	4	0.54	1965	4	2.58	1977	4	4.29			
1954	1	0.55	1966	1	2.66	1978	1	4.28			
1954	2	0.57	1966	2	2.69	1978	2	4.32			
1954	3	0.58	1966	3	2.73	1978	3	4.75			
1954	4	0.59	1966	4	2.69	1978	4	5.35			
1955	1	0.60	1967	1	2.71	1979	1	5.64			
1955	2	0.62	1967	2	2.74	1979	2	5.67			
1955	3	0.64	1967	3	2.76	1979	3	5.85			
1955	4	0.67	1967	4	2.75	1979	4	6.90			
1956	1	0.68	1968	1	2.78	1980	1	7.75			
1956	2	0.71	1968	2	2.80	1980	2	6.71			
1956	3	0.74	1968	3	2.82	1980	3	6.10			
1956	4	0.77	1968	4	2.81	1980	4	8.09			
1957	1	0.94	1969	1	2.84	1981	1	8.89			
1957	2	0.99	1969	2	2.85	1981	2	9.26			
1957	3	1.03	1969	3	2.90	1981	3	9.93			
1957	4	1.05	1969	4	2.86	1981	4	8.66			